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Spatial distributions of global soil moisture retrievals from satellite microwave observations

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ABSTRACT

A global data base of daily surface soil moisture has been compiled by applying a recently developed land parameter retrieval algorithm to a nine year historical data set of brightness temperatures from the Scanning Multichannel Microwave Radiometer (SMMR). The instrument, flew on-board the Nimbus-7 satellite, and made daily daytime and nighttime global observations of brightness temperature at five frequencies and two polarizations from 1978 to 1987. Spatial distributions of global soil moisture are examined, and they compare well with corresponding observations of global precipitation and global vegetation indices.

Keywords: Remote sensing, soil moisture, microwave brightness temperature, global climate

1. INTRODUCTION

Soil moisture is an important component of many Earth science research disciplines and is a key parameter in energy balance and radiative transfer-based applications, such as land process models, climate prediction models, and numerical forecast models. Soil moisture has been identified as a parameter of considerable importance by a number of global change research programs, as a means for improving the accuracy of large-scale land surface-atmosphere interaction models. Soil moisture is also thought to be the single most important parameter influencing the atmospheric circulation over land during the summer. Improved estimates of spatially representative surface moisture will significantly enhance both short and long-term precipitation forecasts. Long term soil moisture trends could potentially serve as drought indicators, and historical monitoring could provide important information on climate and other environmental change.

The manner in which soil moisture is used in various research applications, usually determines its parameterization in terms of accuracy, spatial, and temporal requirements. Soil moisture typically exhibits a high degree of spatial and temporal variability. Most forms of temporal variability are usually well understood; e.g. normal seasonal variation over the course of a year. However, recent extremes in the seasonal cycle of various environmental parameters such as temperature and soil moisture have resulted from unusual seasonal to interannual climate variations. Many of these extremes appear to be related to anomalies in global circulation patterns and sea surface temperatures, and are not yet fully understood. Spatial variations in soil moisture are also not entirely intuitive. While spatial differences are clearly a function of rainfall distributions, they are also the result of topography, heterogeneity of soil physical properties, and vegetation characteristics. Knowledge of the three-dimensional soil moisture distribution and its relationship to evapotranspiration is key to understanding the subsequent influence of land surface processes on weather and climate. However, despite its recognized importance, routine global observations of soil moisture, an understanding of its spatial and temporal distribution, and a thorough understanding of its affect on global circulation is still lacking. Remote sensing provides an excellent opportunity to study the various aspects of the land surface on a global scale, and the development of new satellite retrieval algorithms permits researchers to monitor many parameters on highly improved spatial and temporal scales. A recently developed land surface retrieval model uses radiative transfer theory along with microwave brightness temperature observations to derive surface soil moisture, vegetation optical depth, and surface temperature. While the model is still undergoing refinement in several areas, global retrievals of land surface parameters are consistent with major climate zones and other environmental indicators and demonstrate good response to interannual climate changes.

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